

REMARKS

Claim 16 and newly added claim 21 are all the claims pending in the application.

The Examiner has withdrawn all of the previous rejections in the application, but has set forth new rejections based on newly cited prior art.

Claim 16 has been rejected under 35 U.S.C. § 103(a) as obvious over Farid et al in view of Harada et al and Swainson et al. Each of these references are newly cited.

Applicants submit that the cited documents do not disclose or render obvious the subject matter of the present claims and, accordingly, request withdrawal of this rejection.

The present invention is directed to a method for inducing a non-resonant two-photon absorption, which comprises irradiating a non-resonant two-photon absorbing material comprising an oxonol dye undergoing a non-resonant two-photon absorption with a laser ray having a wavelength longer than the linear absorption band of the dye and present in the range of 400 to 1,000 nm to induce a two-photon absorption

In essence, the Examiner states that Farid et al disclose a composition comprising an oxonol dye PS 31 (shown in Table I), a binder, a monomer, an inhibitor and an activator. The Examiner states that dye PS 31 has an absorption maximum of 453 nm. The Examiner points out that Farid et al disclose other sensitizers, such as cyanine dyes PS 1 to PS 2, styryl dyes PS 13 to PS 20, xanthene dyes PS 32 and PS 33, as well as merocyanine dyes, hemioxonol dyes and hemicyanine dyes.

The Examiner states that Harada et al disclose the curing of a photopolymerizable composition using a two-photon process. The Examiner states that the light is an ultrashort pulse

from a Ti:Sapphire, which emits a pulse of 100-300 fs pulse at a wavelength within the range of 700-900 nm.

The Examiner further states that Swainson et al disclose that the use of two-photon processes is old and well known in the imaging arts. The Examiner states that in the embodiments of Class I, Group 2, two photons of the same wavelength are used to cause the photoreaction by a simultaneous multi-photon absorption system. The energy difference between the two states is greater than the energy of a single photon, but equal or less than twice the energy of the photon.

The Examiner states that Swainson et al disclose that the starting point for a two-photon process is a material having known one-photon photoresponsive properties. See col. 2, lines 39-46.

The Examiner states that Example 3 of Swainson et al is a photopolymerization system that includes the xanthene dye sensitizer eosin Y, as disclosed at col. 5 line 30 to col. 6, line 35, and that two-photon sensitivity of cyanine dyes is disclosed at col. 12, lines 48-51. Applicants assume that the Examiner is referring to the example in paragraph “(4)” at column 6, lines 29 to 35 of Swainson et al, which discloses eosin Y, since the example in paragraph “(3)” at column 6 of Swainson et al does not disclose eosin Y.

The Examiner argues that it would have been obvious to modify the process of Farid et al in the Examples using the oxonol dye PS 31 by using a two-photon exposure process with a Ti:Sapphire laser attuned to a wavelength of 900 nm, which is near the two-photon absorption maximum of about 906 nm, taught by Harada et al. The Examiner states that it would have been obvious to do so to increase the resolution of the imaging process as discussed by Harada et al.

The Examiner further states that there would be a reasonable expectation of exciting the two-photon polymerization based upon the teachings of Swainson et al, which show this for cyanine and xanthene dyes, and which show that establishing a good starting point for a two-photon system is a compound having a single-photon response, which is established for the oxonol dye PS 31 by Farid et al.

Thus, the Examiner appears to be arguing that in view of Swainson et al, it would be obvious to subject any dye which is known to have a single-photon response to a two-photon absorption. The Examiner further reasons that since Swainson et al disclose a two-photon absorption of the xanthene dye eosin Y, and since Farid et al disclose that oxonol dyes and xanthene dyes can be used interchangeably, it would be obvious that the oxonol dyes of Farid et al can be subjected to two-photon absorption, especially since Harada et al disclose a suitable apparatus that can be used for the two-photon absorption.

In response, applicants submit that there is no teaching or suggestion in Farid et al, Harada et al or Swainson et al that an oxonol dye is a non-resonant two-photon absorbing material and that it could be irradiated to induce a non-resonant two-photon absorption.

Farid et al do not disclose or suggest a non-resonant two-photon absorption of any kind, and merely disclose a conventional one-photon reaction. Harada et al disclose the curing of a photopolymerizable composition by a multiple photon absorption phenomenon, but do not disclose or suggest a method of inducing a non-resonant two-photon absorptions by irradiating an oxonol dye to induce a non-resonant two-photon absorption.

The Swainson et al patent discloses a simultaneous multi-photon absorption for the xanthene dye sensitizer eosin Y. This system is based on a non-resonant two-photon absorption.

The discussion of eosin Y in Swainson et al appears under the column 5 heading “SIMULTANEOUS MULTIPHOTON ABSORPTION SYSTEMS”, and the column 5 subheading “Class I Group 2”.

Swainson et al also disclose that cyanine dyes are subjected to a stepwise multi-photo absorption, which is not a non-resonant two-photon absorption. Thus, the discussion of cyanine dyes in Swainson et al at column 12, lines 48 to 51 appears under the subheading “Class II Group 3”, which appears under the heading at column 10 of “STEP-WISE MULTIPHOTON ABSORPTION SYSTEMS.” Since cyanine dyes are classified, according to a higher notion, as polymethine dyes just like oxonol dyes, applicants submit that it would be reasonable for one of ordinary skill in the art, in view of the information disclosed by Swainson et al, to assume that oxonol dyes could be subjected to a stepwise multi-photon absorption process in a similar manner as cyanine dyes.

Applicants submit that the disclosure in Swainson et al that the cyanine dyes are subject to a stepwise multi-photon absorption, and the lack of a disclosure in Swainson et al that the cyanine dyes are subjected to a simultaneous two-photon absorption, teach away from subjecting the oxonol dyes to a simultaneous two-photon absorption, that is, to a non-resonant two-photon absorption as set forth in claim 16. Accordingly, applicants submit that one of ordinary skill in the art would not have been led to combining Swainson et al with the other cited documents, and that one of ordinary skill in the art would not have been led to the subject matter of claim 16 from such a combination since there is no teaching or suggestion that an oxonol dye is a non-resonant two-photon absorbing material that can be irradiated to induce a non-resonant two-photon absorption.

Thus, the Farid et al, Harada et al and Swainson et al patents do not disclose or suggest that an oxonol dye is a non-resonant two-photon absorbing material, and that it can be irradiated to induce a non-resonant two-photon absorption.

Applicants note that Farid et al do not disclose the oxonol dyes of formula (3) of the present application. Accordingly, applicants have added a new dependent claim 21 which recites a dye of formula (3). Claim 21 provides a further basis of patentability over the cited documents.

In view of the above, applicants submit that the cited documents do not disclose or render obvious the subject matter of the present claims and, accordingly, request withdrawal of this rejection.

Claim 16 has been rejected under 35 U.S.C. § 103(a) as obvious over Farid et al in view of Harada et al, Swainson et al and further in view of the Penzkofer et al article.

Applicants submit that the cited documents do not disclose or render obvious the subject matter of the present claims and, accordingly, request withdrawal of this rejection.

The Examiner cites the Penzkofer et al article for teaching a two-photon absorption of the trimethine dyes HMICI and PYC. The Examiner states that the PYC dye contains ketone-containing terminal moieties which are similar to those of an oxonol dye. The Examiner, therefore, believes that since Penzkofer et al disclose that ketone-containing terminal moieties can be used in two-photon absorption, this suggests that oxonol dyes can be used in two-photon absorption.

In addition, the Examiner states that the Penzkofer et al article discloses two-photon absorption dynamics of organic dye solutions. The Examiner states that this further supports the

position that the oxonol dye PS 31 of Farid et al will have an appreciable two-photon absorption cross-section sufficient to cause two-photon polymerization.

In response, applicants submit that the Examiner's analysis of Penzkofer et al is not correct and the teachings of Penzkofer et al do not disclose or suggest that oxonol dyes can be subject to a non-resonant two-photon absorption.

In particular, the Examiner's understanding that the dye PYC subjected to two-photon absorption contains a ketone-containing terminal moiety and thus, oxonol dyes can also be used for two-photon absorption, has no chemical basis at all.

The chemical feature of dye PYC lies in the fact that it is a cyanine dye having a cyanine chromogenic group (a conjugate system comprising plural repetitions of a double bond and a single bond with a positive charge), whereby the ketone moiety located at the terminal of dye PYC is directly associated with the cyanine chromogenic group, which characterizes the chemical properties of dye PYC, but the ketone moiety in dye PYC is a simple substituent that does not contribute to its chemical properties.

On the other hand, the chemical characteristics of oxonol dyes are derived from the structure comprising plural repetitions of a double bond and a single bond together with oxygen atoms located at both ends of the repetitions and having a negative charge, whereby the ketone moiety is directly associated with the conjugate system, thus characterizing its chemical characteristics.

As has been described in detail above, the two kinds of ketone moiety, though they appear structurally similar to each other, play completely different roles, whereby the ketone

moiety in dye PYC does not characterize its chemical characteristics, while the ketone moiety in oxonol dyes is essential for the development of their chemical characteristics.

In other words, it is unreasonable from a chemical viewpoint to expect an effect similar to that in the cited Penzkofer et al reference for a compound (oxonol dye) which is completely different in electronic property from the compound in the Penzkofer et al article (dye PYC) only for the reason that a ketone moiety is contained somewhere in the molecular structure of both compounds.

Further, the two-photon absorption cross-section for the two cyanine dyes HMICI and PYC disclosed in Penzkofer et al, are $(2 \pm 0.2) \times 10^{-49} \text{ cm}^4 \cdot \text{s}$ and $(1.8 \pm 0.2) \times 10^{-49} \text{ cm}^4 \cdot \text{s}$, respectively, according to Table 1, at page 333 of Penzkofer et al. Since 1 GM is defined to be $1 \times 10^{-50} \text{ cm}^4 \cdot \text{s}$, the two-photon absorption cross-sections of these compounds are roughly 20 GM.

On the other hand, the two-photon absorption cross-sections of the compounds falling within the scope of the present claims are far larger than those of the cyanine dyes in Penzkofer et al in orders. Thus, the present invention exhibits an effect far exceeding any predictable degree from Penzkofer et al. Applicants point out that among the exemplary oxonol compounds disclosed in the present specification, even the compound having the smallest two-photon absorption cross-section, namely, compound D-192, has an area of 1,200 GM, which far exceeds the roughly 20 GM cross-sections of the two cyanine dyes of Penzkofer et al. See Table 1 at pages 77 to 78 of the present specification.

In view of the above, applicants submit that the cited documents do not disclose or render obvious the subject matter of the present claims and, accordingly, request withdrawal of this rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

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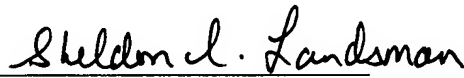
Respectfully submitted,

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE

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CUSTOMER NUMBER


Sheldon I. Landsman
Registration No. 25,430

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